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THE COURSE IN NATURAL SCIENCE IN THE UNIVERSITY ELEMENTARY SCHOOL. II

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GRADE IV

Specific aims, methods, and standards of attainment.—In this grade the pupil's acquaintance with his natural surroundings is still further extended. Much of the material is already somewhat familiar, but he makes a more intensive study of a few topics. The course deals especially with certain forms of animal life of the fields, the pond, and the home; with the plant life of the school garden and the home gardens; and with the physical conditions favorable for such animal and plant life.

In the study of animal life the aim is to acquaint the pupils first with the habitats and then with the habits and life-histories of the animals studied. For this purpose the children are taken several times to the fields, woods, and ponds, where such specimens are collected as can be kept growing in the classroom for further study. On the field trips and in the classroom the teacher aims to stimulate direct observation by asking guiding questions, the answers to which are to be given orally or in writing while observing the animals. Observation is accompanied or followed by drawing on paper or on the blackboard. Both teacher and class criticize the blackboard drawings. Later the children use models and pictures of the animals studied, as well as books.

The aquaria in the classroom contain water insects, crayfish, frogs, fish, etc.; and cages of wire and glass afford opportunities for growing and studying other insects and spiders. Cocoons are kept through the winter to enable the children to watch developments.

To take advantage of the developing sense of responsibility and ownership the children are given individual garden plots. Plans are drawn to scale for planting, and seeds are selected with the teacher's help. The child cares for his plot and owns what he is able to grow. This causes his feeling of responsibility to deepen. The problem of weeds and their relation to successful gardening becomes impressive. During the summer vacation a man cares for the garden, and so the children secure at least a partial harvest in the fall.

In the bird work it is the aim to keep active the previous acquaintance with birds and to add to the list more winter and spring birds, mainly by observation in the parks and gardens. The pupil's interest in nesting habits is fostered by observing more closely the building of nests by some of the common birds.

OUTLINE OF MATERIALS AND ACTIVITIES

A. Fall and winter work
  1. Plant life
    a) Pupils collect seeds from their third-grade plot and preserve for spring planting. They observe conditions of the garden in the fall and write about them.
    b) Bulb-planting. This work is not so intensive as in the third grade, but the children plant a few varieties in pots or in the garden. Two bulbs are given each child to take home and plant; reports on results are given in class. Some bring the flowering plants to school.
  2. Land-animal life
    a) Spiders. Children collect them from the gardens, fields, and buildings for classroom work, place them in wire or glass cages, and observe web-making and feeding habits.

    Paper and blackboard sketches of spiders are made.

    Some of the following are studied from life, others from pictures and books: house spiders, grass or funnel-web spiders, orb weavers or garden spiders, ballooning spiders, running spiders, jumping spiders, crab spiders, trap-door spiders.
    b) Butterflies and moths. The children bring in specimens of caterpillars, chrysalides, and cocoons. Mounted specimens also are used. Life-histories are studied.

    Silkworms and the silk industry are studied.
    c) Plant lice. Their habits. Lady beetles, the destroyers of plant lice.

d) Crickets. Live specimens are kept in cages with grass sods. Habits are studied by observation.

e) Earthworms. These are kept in a pan of soil. Some are used to feed the fish through the winter. Pupils study their habits and their value to agriculture.

f) Snails. Children collect and study land specimens.

g) Wasps. Yellow jackets and white-faced black hornets are studied, mostly from books and pictures.
  (1) Nests; how and where built. Museum exhibit.
  (2) How do cells open, upward or downward?
  (3) Use of these cells.
  (4) "Nurses."
  (5) Food: honey and other sweets; also some insects.
  (6) Do the wasps survive the winter? Where does the queen hibernate?
  (7) Mud-daubers, jug-builders, digger wasps, and carpenter wasps.

3. Water animals
  a) Children collect many kinds on field trips and keep them in aquaria. The teacher uses a canvas dip-net; as he brings the animal life to the surface the children assort it and place specimens in their bottles or cans. The specimens are taken to the school and placed in large jars or other aquaria. Children learn to feed them and observe their habits. Pupils are given a list of questions to answer on paper while observing each animal. For closer study the animals are placed in separate dishes so that small groups of children can gather about and observe them. Pictures are sketched in notebook and colored. Also blackboard drawings are made. A little story about each is written and kept in the notebook.
  b) Following are some of the animals used: large giant and small giant water bugs, back swimmers, water boatmen, dragon-fly nymphs, whirligig beetles, crayfish, water scorpions, turtles, fish, water striders.

4. Household insects

The study of household insects is made not so much from an economic viewpoint as from that of sanitation.

The housefly, mosquito, house ant, clothes moth, and cockroach are studied as to life-history and habits, main structural parts, and relation to health and cleanliness.

5. Brief study of preparation of animals for winter
  a) Those that hibernate.
  b) Those that grow heavier hair.
  c) Those that migrate.
  d) Those that store up food.

B. Spring work
  1. Birds
    a) This work begins in the late winter with the study of winter birds (continued from the third grade) and is carried on through the spring migration. The major purpose of the bird work in this grade is to get a better acquaintance with the habits of birds observed in preceding grades.
    b) When possible, trips are taken to the park to study birds. Specimens may be brought from the museum and identified.
    c) Habits of birds: manner of getting food, mode of flight, hopping or walking, etc.
    d) Nesting habits of the robin, blue jay, grackle, and wren.
    e) Bills of birds: hooked bills for tearing food, seed bills, and pecking bills.
  2. Gardens
    a) Pupils have individual plots. They make a drawing of the garden to scale and make definite plans with regard to what and how to plant. Then they prepare the ground, plant the seeds, and once or twice a week until school closes they work in the garden caring for their plots and the growing plants.
    b) The points discussed in connection with this work are:
      (1) How to prepare the soil.
      (2) How to plant the different seeds.
      (3) When and how to water plants.
      (4) What to transplant and how.
      (5) Thinning out.
      (6) Weeding.
    c) The pupils are sole owners of all the flowers and vegetables raised in their plots and may sell them, give them away, or take them home.
    d) When possible, field trips are made to study wild flowering plants and common weeds, such as pigweed, ragweed, cocklebur, prickly lettuce, shepherd's purse, peppergrass, thistle, parsley, etc.

A TYPE LESSON

(Detailed outline of the study of the crayfish to show method of work in class)

1. From the crayfish aquarium in the room enough of the animals are selected so that groups of four children may each have one in a glass dish for observation.

2. On the board is placed a list of questions for the pupils to answer on paper. They copy the questions, leaving several lines after each question for the answer, which is gained from observing the animal.
   a) How many legs has the crayfish?
   b) Describe the largest pair of legs.

  - *c*) What is peculiar about the eyes?
  - *d*) How many "feelers" has it?
  - *e*) What kind of tail has it?
  - *f*) How many parts has the body?
  - *g*) How does it move in the water?
  - *h*) How does it feed itself?
3. In the next lesson the answers given to the foregoing questions are talked over and any additional facts of general interest about the crayfish are given, such as its habitat, summer and winter; its method of carrying the eggs; method of swimming; growing new shells. Interesting articles or stories about the crayfish are read in class.
4. The children next write a paper about the crayfish, including many of the facts observed, discussed, and learned in class. The papers are corrected and neatly copied.
5. Each pupil draws the crayfish from life. The teacher makes a simple drawing of the main features on the blackboard as a guide. After one or two trials each draws one which is to be colored. Drawing paper is used.
6. Each mounts his drawing on bogus paper and hangs it up in the room with the rest until the next lesson, when it is put with the paper in his notebook.

Class time for work and preparation.—All the work is done in the class-periods. Three half-hours a week are given to the subject. No time out of school hours is required except for certain field trips.

Books used in class by the pupils.—No textbook is used in this grade for this subject. Some library books and articles bearing on the lessons are used in the class-period, and near the close of a series of lessons textbook illustrations are often inspected.

Notebooks are used for drawings of animals, for taking notes of observations, and for writing stories and life-histories.

References for the teacher.—

1. Spiders
   - Caldwell, *Elementary School Teacher*, March, 1910.
   - Patterson, *The Spinner Family.*
   - Hodge, *Nature Study and Life.*
   - Kelly, *Stories of Our Shy Neighbors.*
   - Emerton, *The Common Spiders of the United States.*
   - Comstock, *Handbook of Nature Study.*
   - H. Fabre, *The Life of the Spider.*

2. Insects and related topics (see list above)
    - Holtz, *Nature Study.*
    - Comstock, *Insect Life.*
    - Miall, *Aquatic Insects.*
    - Eggeling and Ehrenberg, *Freshwater Aquarium.*
    - Comstock, *How to Know the Butterflies.*
    - *Nature Study Review*, April, May, and September, 1912.
    - Carpenter, *Insects, Their Structure and Life.*
    - Smith, *Our Insect Friends and Enemies.*
    - Darwin, *Formation of Vegetable Mold.*
    - Tenney, *Young Folks' Pictures and Stories of Animals.*
    - Needham, *Natural History of the Farm.*
3. Fish
    - Jordan, *The Story of a Salmon.*
    - *Alexander's Fourth Reader*, "Johnny Darter."
    - Holder, *Half-Hours with Fishes, Reptiles, and Birds.*
    - Baskett, *Story of Fishes.*
    - Comstock, *Handbook of Nature Study.*
4. Circulars and bulletins
    - Circular 5, U.S. Bureau of Entomology, *The Carpet Beetle or Buffalo Moth.*
    - Circular 36, U.S. Bureau of Entomology, *The True Clothes Moth.*
    - Circular 51, U.S. Bureau of Entomology, *The White Ant.*
    - Circular 50, U.S. Bureau of Entomology, *Cockroaches.*
    - Circular 71, U.S. Bureau of Entomology, *House Flies.*
    - Circular 139, New York State Museum, *Control of Household Insects.*
    - Bulletin 4, U.S.Bureau of Entomology, *Household Insects of the United States.*

GRADE V

Specific aims, methods, and standards of attainment.—For closely correlated work see domestic science outline for the fifth grade.

To connect the work of the fourth and fifth grades a fall review study of the garden is made, and seeds are collected from the plots for which the children cared during the previous spring. These seeds are preserved for future planting by younger grades. A description of the garden is written. After this a type plant, corn, is studied in much more detail than any plant in previous grades. The aim in this work is, not only to acquaint the child with germination and factors of growth, but to emphasize the uses to which such an important agricultural product is put. Such topics as the history of corn, some problems in raising corn crops, and industries connected with corn products are included. The children become interested in the process of making some of the corn products, such as starch, cornmeal, and corn breakfast foods.

A later phase of the course includes experimentation in fermentation, with hard and soft water, with porous substances, with dissolving and melting substances, and in making butter, soap, and candles.

The garden work is made more intensive and interesting by studying soils to find their composition, how they are made, and the power they have to draw up and to hold water. Some experiments are performed in seed germination, and others to show the importance of air, warmth, food, light, and water as factors in the growth of plants. Some methods of farmers and hothouse men to fertilize the soil and to reproduce plants by cuttings and grafts are discussed.

Bird life is again studied as important to gardens, farms, and orchards.

OUTLINE OF MATERIALS AND ACTIVITIES

A. First semester
  1. Fall garden study

     Pupils visit the garden, study its harvest condition, and collect seeds for spring planting.
  2. Corn—a type plant
     a) The ear
        (1) Pupils gather cornstalks from the garden with roots, ears, etc., left on. Ears of both field and pop corn are secured.
        (2) Pupils examine the different ears of corn and learn the names of some good varieties of each.
        (3) Characteristic appearance of dried, field, and sweet corn are noted. Details of such appearance. Good and bad ears and kernels. Average number of rows and of kernels.
        (4) The cob is examined by cutting it longitudinally and transversely.
     b) The kernel
        (1) Pupils examine grains of different kinds of corn, both fresh and dried. They locate tip, hull, and position of germ, and remove germ and starch.
        (2) A kernel is drawn showing all parts.
        (3) Kernels are planted in various ways to determine vitality and to study sprouts and root systems. Sprouts with roots are sketched.

- (4) Pupils grind kernels in coffee grinder to make corn meal.
- (5) To learn the many uses to which corn is put the pupils look up literature, write to the United States Department of Agriculture for bulletins, and ask manufacturing companies for exhibits and pamphlets.

c) Starch
- (1) Pupils perform experiments in separating starch from corn meal, flour, and potatoes.
- (2) They test starch with iodine.

d) Corn as food for man: milled products and canned products
- (1) Corn flakes, hominy, corn syrup, and other corn foods are studied from specimens, books, bulletins, and pamphlets.
- (2) Pupils test corn syrup for sugar by using Fehling's solution and heat.
- (3) Pupils test a number of foods, fruits, and vegetables for starch, sugar, and water.
- (4) Corn meal. Pupils make muffins or other articles of food from it.

e) Corn as food for animals
- (1) Pupils study uses of corn gluten, ensilage, cracked and whole corn.

f) Other products made from corn
- (1) Corn rubber or paragol, corn-leaf baskets, corn paper, cellulose, dextrine, mattresses, pipes, cork, alcohol, and whiskey.

g) Study of stalks, leaves, roots, etc.
- (1) Pupils cut stalk and examine, noting hollow stalk, pith, woody fiber, nodes, and internodes.
- (2) Leaves. Made up of sheaf, blade, and ribs. Rain guard, situation, and use.
- (3) Ears. Where placed? How many on a stalk? Position when ripe? How fertilized by pollen? Husks?
- (4) Tassel. Its position and function.
- (5) Silk. Position, and relation to pollen and kernels.
- (6) Roots. Brace roots and other roots.

h) Enemies of corn
- (1) Pupils look up bulletins and other literature on corn-root louse, chinch bug, corn-ear worm, fly weevil, smut, corn-ear rot, corn-eating birds, etc.

i) Importance of corn to the world
- (1) Pupils look up topics and report.

j) Corn industries. Reports and discussions

k) History of corn

l) The United States corn belt. Relation of climate and soil to corn growing

m) Morning assembly exercises on corn

3. Other science topics
   - *a*) Fermentation
     - (1) Pupils perform experiments with yeast, water, and molasses to see fermentation and some of its results.
   - *b*) Hard and soft water
     - (1) Pupils determine the smallest amount of soap which will make suds with distilled water, faucet water, boiled water, lime water, and faucet water with washing soda in it. They learn that soft water forms suds easily. Application to laundering and bathing.
   - *c*) Solubility and dissolving
     - (1) Pupils test solubility in water of various substances, such as salt, sugar, starch, gelatine, soda, lime, alum, potash, chalk, glass, wood. In each case a spoonful of the clear liquid is evaporated over a gas flame to see if any of the substance was dissolved in it.
     - (2) Pupils try hot water to see if it dissolves alum, etc., better than cold water.
     - (3) Difference between dissolving and melting. Pupils heat salt, sugar, starch, soda, resin, lead, wax, sulphur, etc., separately in an iron pan and note results.
     - (4) Pupils try alcohol, strong soda water, and soapy water to see if they dissolve things which water does not.
     - (5) Pupils mix a little baking powder and cream of tartar in a tumbler. Add water to dissolve them. What causes the bubbling? Relation of this gas to the making of bread?
   - *d*) Milk
     - (1) How keep it sweet? Pupils put a little milk into several clean bottles. Leave one open in room. Put a pinch of borax into second and leave in room. Put a third in the refrigerator or other cold place. Pasteurize a fourth. Examine each for a few days and determine the order of souring.
   - *e*) Fats
     - (1) In butter-making. Pupils make butter from simple directions.
     - (2) In soap-making. Pupils make a simple soap and use it.
     - (3) In candle-making. Pupils make candles by molding and dipping processes.

B. Second semester
1. Soil study

   To get a concrete idea of what soils contain and the factors which help in making soils fertile, several simple experiments are performed by pupils. This work amplifies soil study of the Fourth Grade.
2. Plant reproduction
   - *a*) Pupils review propagation by bulbs, seeds, tubers, etc., and then propagate by

(1) Cuttings. Using a few of such plants as geranium, wandering Jew, coleus, begonia, rose, fuchsia, carnation, willow, lilac, grape, the pupils plant some cuttings in very sandy soil. They transfer to pots when well started. Some cuttings are tried in glasses of water. Advantages of this method?

(2) Grafting. Cuts in twigs or stems are made to show how grafting is done.

(3) Runners and roots. Pupils bring in samples.

(4) Underground stems and layering. Examples and methods are shown.

3. Garden work
   - *a*) Early in the spring pupils draw plans of individual plots to scale, and decide upon what seeds to plant.
   - *b*) When ground is in condition pupils prepare their plots, plant seeds, and care for their gardens until school closes. A man cares for the gardens in the summer so that the children will have a harvest in the fall. Most of the pupils do not spend the summer in Chicago.
   - *c*) In this grade each pupil is held responsible for industry and care in the cultivation of his garden.
4. Bird study
   - *a*) Review of birds studied in preceding grades.
   - *b*) Occasional trips to park to study birds.
   - *c*) Economic factors
     - (1) What and how much birds eat.
     - (2) Feeding places of birds and feeding habits.
     - (3) Relation of bird life to agriculture, horticulture, and gardening.
     - (4) Bird and game laws.
     - (5) Migration of birds.

A TYPE LESSON

1. Simple analysis of soil
   - *a*) Pupils weigh, in iron pans, 100 grams of garden soil and heat gently to dry out moisture. Estimate amount of moisture by weighing again.
   - *b*) They heat the soil again strongly to burn out the organic matter and estimate amount by weighing.
   - *c*) Next they sift the soil through coarse and fine sieves to separate gravel, coarse and fine sand, and silt. Each is weighed.
   - *d*) Some of each ingredient is put into bottles which are mounted on cardboards and labeled.
   - *e*) If there is time the pupils bring soil from home and from different regions and analyze.
   - *f*) Pupils put seeds or plants in some of the ingredients found in soil to see if they will grow.
   - *g*) Pupils examine, with lens, some sand, loam, and humus.

2. Water-holding power of soils
    - *a*) Pupils put equal amounts of sand, clay, and garden soil into separate lamp chimneys, tie cheesecloth over bottom, and suspend chimneys over glasses. They pour equal amounts of water into the chimneys and observe which lets water through first, and which absorbs and holds the most water.
    - *b*) Of what importance is this to plant growth?
3. Water-lifting power of soils
    - *a*) With same kind of soils in chimneys as in 2, above, pupils stand the chimneys in glasses which have equal amounts of water in them. They observe the water rise, and note the amount taken up in each case.
    - *b*) Is this a factor in plant growth?
4. Film of water on particles of soil
    - *a*) A bottle is filled with lead shot and water and then the water is strained off. The film of water on each shot illustrates the way in which soil holds water.
5. Mulching
    - *a*) To show that mulching keeps water from evaporating so fast from the soil, pupils put soil in two bottles and thoroughly wet it. The wet soil in one bottle is covered an inch deep with dry loose earth. Each bottle is weighed on successive days. Which dries out first?
    - *b*) Application to gardening and farming.
6. Capillary water
    - *a*) Pupils perform simple experiments with string or wicking, lumps of sugar, and water to understand something of capillarity.
    - *b*) Application to soil water.
7. How soil is made
    - *a*) Discussion of beginnings of soil formation. Effects of running water, temperature, winds, plant and animal life, wave action, glaciers, landslides, etc.
8. How soil is carried
    - *a*) Readings and talks on the effects of water, wind, glaciers, landslides, etc.
9. Kinds of soil
    - *a*) Pupils study sandy soil, clayey soil, gravel, humus, and loam. Distinctive features of each.
10. Soil replenishment
    - *a*) Various ways of enriching the soil. Rotation of crops. Relation of clover, alfalfa, etc., to soil replenishment. Overflowing of river banks.

11. Soil conditions favorable to plant growth
    - *a*) Pupils do simple experiments with potted plants to determine whether the plants need
        - (1) Air
        - (2) A certain temperature
        - (3) Food
        - (4) Light
        - (5) A certain depth of planting
        - (6) Water

Class time for work and preparation.—All the work is done in the classroom periods. Two hours a week is allotted to this subject, divided into hour and half-hour periods. No home work or outside preparation is required. Closely correlated is the work in domestic science in which two hours per week for one semester are allotted in this grade.

Books used in class.—No textbook is used for elementary science in this grade. Articles and books (see "References") are occasionally used in class.

Notebooks are kept in which the pupils write brief descriptions of experiments and important facts learned from class work. This gives needed experience in the written form of expression.

References for the teacher.—

1. Corn
    - *Corn Day Annual*, Superintendent of Illinois Schools.
    - *Eleventh Biennial Report of South Dakota Schools.*
    - *1912 Year Book, Superintendents' and Principals' Association of Northern Illinois.*
    - *Corn and Its Uses*, American Manufacturers Association, Chicago.
    - Government bulletins, state bulletins, and circulars.
2. Soils and plant life
    - Gaye, *The Great World's Farm.*
    - Carpenter, *How the World Is Fed.*
    - Comstock, *Handbook of Nature Study.*
    - Gifford, *Practical Forestry.*
    - Bailey, *Principles of Agriculture.*

[*To be concluded*]